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Development of a Scale to Measure the Attitude of Farmers towards Carbon Sequestration Technologies and Its Application in Rice and Sugarcane Based Farming System

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Abstract

The present study was contemplated to develop and standardize the scale to measure farmer's attitude towards carbon sequestration technologies. Based on the review of literature and discussion with the experts, 40 statements were enlisted. Out of 40 statements, 20 statements were retained in the final scale. The scale developed was found reliable (0.8124) and valid (0.9013). As high as 43.44 per cent of the farmers had 'favourable' attitude towards carbon sequestration technologies in rice and sugarcane based farming system followed by 33.33 and 23.33 per cent of the farmers having 'more favourable' and 'less favourable' attitude towards carbon sequestration technologies in rice and sugarcane based farming system, respectively.

Keywords: Carbon sequestration, attitude, reliability, validity

Agriculture in India is contributing 17.9 per cent towards GDP (2016-17) and provides livelihoods to 50 per cent of the total population (Anon., 2016). Agriculture and food security are among the major casualties of climate change in India. The pace and extent of warming across India is wide spread and undisputed. Climate change is affecting India in a big way and its impacts are many such as serious-erratic monsoon, changes in agricultural zones, spread of tropical diseases, sea level rise, change in the availability of fresh water, floods, droughts, heat waves, storms, etc.

Accumulation of carbon dioxide in the atmosphere causes severe threat to health and survivability of leaving organisms, which leads to gradual extinction of fauna and flora on the earth. Therefore, there is a need to sequestering the carbon in to the soil which facilitates good crop growth and improves the environment. As agriculture is a major contributor of Green House Gases (GHGs) to the atmosphere, there is a need to mitigate carbon dioxide through the adoption of Carbon sequestration agricultural technologies. Studying farmer's attitude towards and adoption of carbons sequestration technologies would help in understanding the ground realities so as to formulate the programs and policies to promote carbon sequestration technologies among the farmers in Rice-sugarcane farming system.

Among the global common concerns, climate change has been identified as the most important environmental challenge faced by human beings. Emission of carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and hydrocarbons are identified as green house gases causing warming of earth globally. Of these gases, CO_2 alone accounts for 60 per cent share. The most practical way of removing excess carbon from atmosphere and storing it in to a biological system is by absorption of atmospheric CO_2 into the physiological system, plant biomass and finally into the soil. Carbon is thus sequestered into the plants and then the animals. Studies have established that Carbon sequestration by trees and forest could provide relatively low cost net emission reduction. Carbon management in forest is therefore one of the most important agenda in India in during the 21st century in context of greenhouse gases effect and mitigation of global climate changes.

The success and failure of any improved technology mainly depends upon the people's mind-set or attitude towards a particular technology. Thus the attitude plays an important role in accepting or rejecting the technology at any stage of the adoption. Attitude scales provided to be useful tools to measure the attitude of large number of individuals towards specific ideas, person, programme, object etc. In this

backdrop, the present study has been carried out with the following specific objectives :

1) To develop and standardize a scale to measure the attitude of farmers towards carbon sequestration technologies and its application in rice and sugarcane based farming system (RSBFS).
2) To analyze the attitude of the farmers towards carbon sequestration technologies in RSBFS and
3) To enlist the constraints of farmers in practising carbon sequestration technologies in RSBFS.

METHODOLOGY

Developing and standardizing attitude scale

Attitude is an organized predisposition to think, feel, perceive and behave towards a cognitive object. Likert (1932) defined attitude is the degree of positive or negative disposition/association towards an innovation, objects, programme etc. Similarly, Thurstone (1946) also defined that attitude is a degree of positive or negative effects associated with some psychological object like symbol, person, institute, ideal or idea towards which people can differ in varying degrees.

Attitude in this study is operationally defined as the positive or negative mental predisposition of farmers towards carbon sequestration technologies in rice and sugarcane based farming system. The method of summated rating suggested by *Likert* (1932) was followed in the development of the scale. The following steps were considered for measuring the attitude of farmers' towards carbon sequestration technologies in rice and sugarcane based farming system.

Collection of statements

Statements related to carbon sequestration were collected by reviewing the journals, books and discussion with experts from Agronomy, Genetics and Plant Breeding and Horticulture. As many as 40 statements related to carbon sequestration were listed and each items was carefully scrutinized to avoid duplication.

Editing of statements

The items collected were edited and modified as per the 14 criteria suggested by Edwards (1969) and Thurstone and Chave (1929). Finally, out of 40 statements, 30 statements were retained as attitude statements and 10 were rejected. These statements were found to be non- ambiguous and non- factual.

Relevancy analysis

The 30 statements were mailed to 90 experts in the Agricultural field of Agricultural Extension, Agronomy, Soil Science and Agricultural field. Chemistry, Environmental science and other related fields working in SAUs, ICAR institutions and Karnataka State Department of Agriculture to critically evaluate the relevancy of each statement on a five point continuum viz., Most Relevant (MR), Relevant (R), Some What Relevant (SWR), Least Relevant and Not Relevant (NR) with the score of 5, 4, 3, 2, and 1, respectively. The judges were also requested to make necessary modifications and additions or deletion of components, if they desire so. A total of 40 judges returned the questionnaires duly completed were considered for further processing. The relevancy score of each statement was ascertained by adding the scores on rating scale for all 40 judges' responses. From this data 'relevancy percentage' and 'mean relevancy score were worked out for all the statements by using the following formulae as below :

$$\text{Relevancy Percentage} = \frac{(MR \times 5) + (R \times 4) + (SWR \times 3) + (LR \times 2) + (NR \times 1)}{\text{Maximum Possible score}} \times 100$$

$$\text{Mean Relevancy Score} = \frac{(MR \times 5) + (R \times 4) + (SWR \times 3) + (LR \times 2) + (NR \times 1)}{\text{Number of Judges responded}}$$

MR = Most relevant
R = Relevant
SWR= Some What relevant
LR = Least relevant
NR = Not relevant
Maximum possible score = 200 (40x5)
Number of Judges = 40

Relevancy percentage was calculated out by summing up the scores of most relevant and not relevant categories, which were converted into percentage. Accordingly statements having relevancy percentage of 80 and above, mean relevancy score of 4.0 and above were considered for further processing and suitably modified as per the comments of experts

wherever applicable. Twenty three statements were isolated in the first stage for development of attitude scale.

Item analysis

These 23 statements were subjected to item analysis to delineate the statements based on the extent to which they can differentiate the respondent with high attitude than the respondent with low attitude towards carbon sequestration technologies. Thirty farmers were selected from non-sample area and the respondents were asked to indicate their degree of agreement or disagreement with each statement on a five point continuum ranging from 'strongly agree" to "strongly disagree". The scoring pattern adopted was 5 to 1, in which 5 score to strongly agree response, 4 to agree response, 3 score to undecided response, 2 to disagree response and 1 to strongly disagree response for the positive statement in case of the negative statement scoring pattern was reversed.

Based upon the total scores, the respondents were arranged in descending order. The top 25 per cent of the respondents with their total scores were considered as high group and the bottom 25 per cent as low group. These two groups provide criterion groups in terms of evaluating the individual statements suggested by Edwards (1969). 't' value was calculated for each of the statement by using the following formula:

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{n(n-1)}}}$$

Where

$$\sum(X_H - \bar{X}_H)^2 = \sum X_H{}^2 - \frac{(\sum X_H)^2}{n}$$

$$\sum(X_L - \bar{X}_L)^2 = \sum X_L{}^2 - \frac{(\sum X_L)^2}{n}$$

$\bar{X}_H$ = The mean score on a given statement for the high group

$\bar{X}_L$ = The mean score on a given statement for the low group

"$X_H{}^2$=Sum of squares of the individual score on a given statement for high group

"$X_L{}^2$= Sum of squares of the individual score on a given statement for low group

"X_H=Summation of scores on given statement for high group

"X_L= Summation of scores on given statement for low group

n= Number of judges in low and high groups

t= the extent to which a given statement differentiate between the high and low groups.

"= Summation

After computing the 't' value for all the 23 statements, 20 statements with highest 't' value equal to or greater than 2.04 were finally selected and included in the attitude scale.

Standardization of scale

The reliability and validity was ascertained for standardization of the scale.

Reliability and validity of the scale

Reliability refers to the precision or accuracy of the measurement or scale. A scientific instrument should yield accurate and similar results both at present as well as over time, even after repeating the experiment/ study several times (Ray and Mondal, 2011). Pre-testing of the attitude scale was done by interviewing 30 farmers in an non sample area. The split half method was employed to test the rehability of the attitude scale. Spear man brown formule was used to to obtain the reliability co-efficient of the whole set. The reliability co-efficient attitude scale was found to be 0.8124, which is higher than the standard of 0.70 indicating higher reliability of the scale, indicating the constructed attitude scale was highly reliable and dependable in its measurement. The data were subjected to statistical validity, which was found to be 0.903, for attitude scale, which is higher than the standard of 0.70. Hence, the validity co-efficient was found to be high and it seemed reasonable to accept the scale as a valid measure of the attitude.

The final attitude scale consists of 20 statements that could be administred to the farmers along a five point continuum representing strongly agree undecided, disagree and strongly disagree with weightage of 5, 4, 3, 2 and 1, respectively, for positive statments. In case of negative statements the scaring pattern follwed is vice-versa. The attitude score of each respondent can be calculated by summating the scores obtained by

each farmers's on all the items. The attitude score on this scale ranges from 20 to 100. The higher score towards attitude indicates that respondent had more favourable attitude towards carbon sequestration technologies and vice-versa.

Results and Discussion

Attitude of farmers towards carbon sequestration technologies

The reliability and validity of the scale indicated the precision and consistency of the results. The scale can also be used to measures the farmers' attitude towards carbon sequestration beyond the study area with suitable modifications (Table I).

It is observed from Table II that more number (43.34%) of the farmers had favourable attitude towards carbon sequestration technologies in rice and sugarcane based farming system followed by 33.33 and 23.33 per cent of the farmers having more favourable and less favourable attitude, respectively.

The probable reason for over majority of farmers having favourable and more favourable attitude towards carbon sequestration technologies in rice and sugarcane based farming system is due to the farmers' interest to mitigate the dangerous climate change, reduce the emission of more carbon dioxide and other Green House Gases (GHG'S) to the atmosphere in rice and sugarcane based farming system. Increasing

Table I

Statement considered to measure the attitude of farmer towards carbon sequestration technologies in rice and sugarcane based farming system

Attitude Statements	SA	A	UD	DA	SDA
Aerobic rice cultivation helps in reduction of Green House Gas emission from rice field					
Application of FYM helps to increase in soil carbon in rice and sugarcane based farming system					
Crop rotation with pulses is not benefit in improving carbon seque stration in rice and sugarcane based farming system					
Green manuring improves the soil fertility					
Stubble incorporation in sugarcane improves the soil health condition					
Trash incorporation (sugarcane) reduces the CO_2 emission to atmosphere					
Practicing of SRI (System of Rice Intensification) method of paddy cultivation is not helps the farmers to reduce the climate change					
Micro irrigation techniques improves the irrigation efficiency in rice and sugarcane based farming system					
Organic Farming is highly useful to increase the carbon sequestration					
Integrated Nutrient Management may fails to results in better Bio-mass production rice and sugarcane based farming system					
Reduced tillage sustain the soil fertility in rice and sugarcane based farming system					
Adoption of Agro-Forestry improves the carbon sequestration					
Mulching of Rice straw reduces the carbon emission to the atmosphere					
Straw burning in paddy and thrash burning in the sugarcane releases more CO_2 to atmosphere					

Attitude Statements	SA	A	UD	DA	SDA
Water stagnation throughout the season in the paddy field releases more amount of methane to atmosphere					
Weed management through cover crops in sugarcane helps in better carbon sequestration					
Site Specific Nutrient Management helps in carbon sequestration in rice and sugarcane based farming system					
Mulching may not beresults better carbon sequestration in rice and sugarcane based farming system					
Excessive application of Nitrogenous fertilizers in the paddy and sugarcane based farming system induces the climate change					
Introduction of Earthworms improves the health condition					

SA: Strongly agree; A: Agree; UD: Undecided; DA: Disagree; SDA: Strongly disagree

TABLE II

Distribution of farmers based on their attitude towards carbon sequestration technologies in rice and sugarcane based farming system

(n=30)

Attitude category	Number	Per cent
Less favourable	7	23.33
Favourable	13	43.34
More favourable	10	33.33
Total	30	100.00

Mean = 81.66; S.D = 2.77

the carbon sequestration in the rice and sugarcane based farming system also helps in the improving the soil fertility leads higher productivity of crops. These results are conformity with the studies of Shankar (2011), Muttanna (2012) and Vinay Kumar (2015).

Low technical knowledge about the carbon sequestration technologies in rice and sugarcane based farming system and difficulty to practice the technologies like aerobic rice and System of Rice Intensification (SRI) due to excess availability of water in command area etc were the reasons for 23.33 per cent of the farmers having less favourable towards carbon sequestration technologies in Rice and Sugarcane based farming system.

Constraints faced by the farmers in practicing carbon sequestration technologies

The data in the Table III revealed that, major constraints faced by farmers to practice carbon

TABLE III

Constraints of farmers in practicing of carbon sequestration technologies in rice and sugarcane based farming system.

Constraints	Rank
Non availability of labours	I
Low price for their produce in the market	II
Difficult to practice technologies with lower knowledge level	III
Absence of water management techniques	IV
Non – availability of inputs	V
Lack of awareness about carbon sequestration	VI
No subsidies on promoting of new carbon sequestration technologies	VII

sequestration technologies were, non-availability of labours in the village (Rank I), followed by low price for the produce in the market (Rank II). Difficult to practice technologies with low knowledge level (Rank III), absence of water management techniques (Rank

IV), non- availability of inputs (seeds, agro-chemicals, etc) (Rank V), lack of awareness about carbon sequestration (Rank VI) and no subsidies on promoting of new carbon sequestration technologies (VII). These results are in line with Shankar (2011) and Vinay Kumar (2015).

The reliability and validity of the scale indicated the precision and consistency of the results. Farmers have favourable attitude towards carbon sequestration technologies in rice and sugarcane based farming systems, as they knew about the application of carbon sequestration and impact of climate change on cropping system and human health. High wage rate and the non-availability of laborers were the major problems of farmers.

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